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Pacific Region

Proceedings of the Pacific regional peer review on evaluating transfers of harvested shellfish products, from the west to the east coast of Vancouver Island, as a potential vector for European Green Crab (*Carcinus maenas*) and other non-indigenous invertebrate species

December 3-4, 2013
Nanaimo, British Columbia

Chairperson: Nicholas Duprey
Editors: Janet Lochead and Nicholas Duprey

Fisheries and Oceans Canada
Pacific Biological Station
Science Branch
3190 Hammond Bay Road
Nanaimo, BC V9T 6N7

December 2015

Canada

Foreword

The purpose of these Proceedings is to document the activities and key discussions of the meeting. The Proceedings may include research recommendations, uncertainties, and the rationale for decisions made during the meeting. Proceedings may also document when data, analyses or interpretations were reviewed and rejected on scientific grounds, including the reason(s) for rejection. As such, interpretations and opinions presented in this report individually may be factually incorrect or misleading, but are included to record as faithfully as possible what was considered at the meeting. No statements are to be taken as reflecting the conclusions of the meeting unless they are clearly identified as such. Moreover, further review may result in a change of conclusions where additional information was identified as relevant to the topics being considered, but not available in the timeframe of the meeting. In the rare case when there are formal dissenting views, these are also archived as Annexes to the Proceedings.

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SUMMARY

These Proceedings summarize the relevant discussions and key conclusions that resulted from a Fisheries and Oceans Canada (DFO) Canadian Science Advisory Secretariat (CSAS) Regional Peer Review meeting on December 3-4, 2013 at the Pacific Biological Station in Nanaimo, BC. DFO has recently taken over responsibility for the management of the aquaculture fisheries in BC from the BC Ministry of Agriculture (BC MoA). A Research Document evaluating the transfers of shellfish products, from the west to the east coast of Vancouver Island, as a potential vector for invasive European Green Crabs (*Carcinus maenas*) and other invertebrate non-indigenous species (NIS) was presented for peer review.

In-person participation included DFO Science and Fisheries Management (FM) staff as well as invited representatives from the Province of BC, Parks Canada, Canadian Food and Inspection Agency (CFIA), and the commercial aquaculture fishing sector.

The conclusions and advice resulting from this review will be provided in the form of a Research Document and a Science Advisory Report providing advice to DFO Science and FM on the potential for shellfish to act as a vector for European Green Crabs and other NIS.

The Research Document and supporting Science Advisory Report will be made publicly available on the Canadian Science Advisory Secretariat (CSAS) website.

Compte rendu de l'examen par les pairs de la Région du Pacifique sur l'évaluation du transfert de produits de mollusques récoltés de la côte ouest vers la côte est de l'île de Vancouver comme vecteur potentiel du crabe vert (*Carcinus maenas*) et d'autres espèces invertébrées non indigènes

SOMMAIRE

Le présent compte rendu résume l'essentiel des discussions et conclusions de la réunion régionale d'examen par des pairs de Pêches et Océans Canada (MPO) et du Secrétariat canadien de consultation scientifique (SCCS) qui s'est tenue du 3 au 4 décembre 2013 à la Station biologique du Pacifique de Nanaimo, en Colombie-Britannique. Le MPO a récemment repris du ministère de l'Agriculture de la C.-B. (BC MoA) les responsabilités de la gestion des pêches aquacoles du Pacifique dans cette province. Un document de recherche évaluant les transferts de produits de mollusques et de crustacés récoltés de la côte ouest vers la côte est de l'île de Vancouver comme vecteur potentiel du crabe vert (*Carcinus maenas*), une espèce envahissante, et d'autres espèces invertébrées non indigènes, a été présenté aux fins d'examen par les pairs.

Les participants en personne incluaient des employés des secteurs des Sciences et de la Gestion des pêches (GP) du MPO ainsi que des représentants invités de la province de la C.-B., de Parcs Canada, de l'Agence canadienne d'inspection des aliments (ACIA) et du secteur de la pêche commerciale aquacole.

Les conclusions et les conseils qui découlent de l'examen en question seront publiés sous la forme d'un document de recherche et d'un avis scientifique qui doivent offrir des conseils aux secteurs des Sciences et de la GP au sujet du potentiel qu'ont les mollusques d'être des vecteurs du crabe vert et d'autres espèces invertébrées non indigènes.

Le document de recherche et l'avis scientifique à l'appui seront rendus publics sur le site Web du calendrier des avis scientifiques du Secrétariat canadien de consultation scientifique (SCCS).

INTRODUCTION

A Fisheries and Oceans Canada (DFO) Canadian Science Advisory Secretariat (CSAS) Regional Peer Review (RPR) meeting was held December 3-4, 2013 at the Pacific Biological Station in Nanaimo to review a Research Document evaluating the transfers of shellfish products, from the west to the east coast of Vancouver Island, as a potential vector for European Green Crab (*Carcinus maenas*) and other invertebrate non-indigenous species (NIS).

The Terms of Reference (TOR) for the science advice (Appendix C) were developed in response to a request for advice from DFO Fisheries Management (FM) branch. Notifications of the science review and conditions for participation were sent to various representatives with relevant expertise in the subject area, including internal (DFO Science, FM, and Fish Protection) and external (Parks Canada, Canadian Food Inspection Agency (CFIA), Provincial government, and commercial fishing sectors) representatives.

The following working paper was prepared and made available to meeting participants prior to the meeting:

Curtis, L.J.F., Matkin, H, Curtis, D.L., Thompson, M., Choi, F., Callow, P., Gillespie, G.E., Therriault, T.W., and Pearce, C.M. 2013. Evaluating transfers of harvested shellfish products, from the west to the east coast of Vancouver Island, as a potential vector for European Green Crab (*Carcinus maenas*) and other non-indigenous invertebrate species. (CSAP WP2013-P33)

The meeting Chair, Nicholas Duprey, welcomed participants, reviewed the role of CSAS in the provision of peer-reviewed advice, and gave a general overview of the CSAS process. The Chair discussed the role of participants, the purpose of the various RPR publications [Science Advisory Report (SAR), Proceedings, and Research Document], and the definition and process around achieving consensus decisions and advice. Everyone was invited to participate fully in the discussion and to contribute knowledge to the process, with the goal of delivering scientifically defensible conclusions and advice. It was confirmed with participants that all had received copies of the TOR, and draft working paper.

The Chair reviewed the Agenda (Appendix A) and the TOR (Appendix C) for the meeting, highlighting the objectives and identifying the Rapporteur (Jessica Finney). The Chair then reviewed the ground rules and process for exchange, reminding participants that the meeting was a science review and not a consultation.

Members were reminded that everyone at the meeting had equal standing as participants and that they were expected to contribute to the review process if they had information or questions relevant to the paper being discussed. In total, 27 people participated in the RPR (Appendix B).

Participants were informed that Matthias Herborg (Government of British Columbia, Ministry of Environment, Conservation Science Section, Aquatic Invasive Species Coordinator) and Cynthia McKenzie (DFO – Science) had been asked before the meeting to provide detailed written reviews for the working paper to assist everyone attending the peer-review meeting. Participants were provided with copies of the written reviews.

The conclusions and advice resulting from this review will be provided in the form of a Research Document and a SAR providing advice to FM on the ability of shellfish transfers, between the west and east coast of Vancouver Island, to act as a vector for European Green Crab and other invertebrate NIS.

The Research Document and supporting SAR will be made publicly available on the CSAS Science Advisory Schedule.

REVIEW

Working Paper:

Curtis, L.J.F., Matkin, H., Curtis, D.L., Thompson, M., Choi, F., Callow, P., Gillespie, G.E., Therriault, T.W., and Pearce, C.M. 2013. Evaluating transfers of harvested shellfish products, from the west to the east coast of Vancouver Island, as a potential vector for European Green Crab (*Carcinus maenas*) and other non-indigenous invertebrate species (CSAP WP2013-P33)

Rapporteur: Jessica Finney

Presenter: Lyanne Curtis (Lead Author)

PRESENTATION OF WORKING PAPER

Lyanne Curtis gave a presentation that closely followed the major topics from the working paper.

POINTS FOR CLARIFICATION

After the presentation, the Committee had some points for clarification which were addressed by the authors.

The Refuge Island study site was near Pipestem Inlet, which is unique because of its very high density of Green Crabs and it was questioned why this site was selected. The concern was that the site may not be representative and that the high density might bias the results. The authors explained that Refuge Island was selected because it is data-rich. They also commented that densities at the location of the study site, at the mouth of Pipestem Inlet, were not as high as densities seen at the head of the inlet.

Clarification was requested on why the duration of the processor study was only half a year. The authors explained that they were asked to do the study half way through the year and that they were further constrained by paralytic shellfish poisoning issues, time lines for applying for scientific licenses, and fiscal budgets.

It was questioned whether the authors attempted to see if any of the Green Crabs transferred from the west coast to the east coast of Vancouver Island actually survived in the Strait of Georgia. The authors responded that this was beyond the scope of the paper. A committee member who has spent time trapping in areas near CFIA biotoxin monitoring sites in the Strait of Georgia mentioned that they have not found any adult Green Crabs in these areas to date. For clarification, it was suggested that the authors include a sentence referencing previous studies that have found that all of the Strait of Georgia is suitable habitat for Green Crab.

It was suggested that the term "control mussels" be better defined in the document.

WRITTEN REVIEWS AND COMMITTEE DISCUSSIONS

In advance of the meeting, written reviews were solicited from two individuals who are knowledgeable in the area: Matthias Herborg (Government of British Columbia, Ministry of Environment, Conservation Science Section, Aquatic Invasive Species Coordinator) and Cynthia McKenzie (DFO – Science). Both reviewers felt the paper was well written and their full reviews are given in Appendix D.

The reviewers liked the conceptual framework of the paper. They thought the study was well designed and that the research was informative and well applied. The study was viewed as a great addition to the existing literature.

One of the reviewers noted that the request for science advice was specifically for Green Crabs, however it was felt that adding more information on other invasive species in BC, such as tunicates and bryozoans that are present on both the east and west coast of Vancouver Island, would be informative. A risk assessment has shown that risk of invasion is very high for tunicates, and adding some text to the paper on this will help provide some context to the present study. The authors agreed to add a paragraph on invasive tunicate species, and possibly bryozoans if there was sufficient information available.

One reviewer suggested adding some text to the document stating that current patterns between the west coast and east coast of Vancouver Island are unlikely to spread Green Crabs naturally via larval dispersal.

Both reviewers requested that the authors include information on the seasonal patterns and location of Green Crab larvae, noting that the risk of transfer may differ as the availability of larvae changes throughout the year. The authors agreed to add information on the timing and location of larvae.

One reviewer wanted to see clarification in the paper on the method of deployment, duration of deployment, and sample size used in the oyster experiment. The authors committed to clarifying in the text that the oysters were suspended, how long they were suspended for, and the sample size.

A reviewer noted that in the processor study, it was unknown whether Green Crabs were present or absent from the shellfish collection sites, and, if they were present, at what concentrations. The authors explained that the processor study was a late addition to the project and therefore only minimal data could be collected. The authors agreed to add some text to make it clear that they didn't know if Green Crabs were present at the processor collection sites or not.

The roles of the salinity and temperature data were questioned by a reviewer, along with inconsistencies in the scale bars of the temperature and salinity plots. The authors explained that the data indicate that the sites were good habitat for Green Crabs and that it was not intended to show if areas were more inclined to contribute to entrainment. The authors committed to add wording to clarify why the temperature and salinity data were included and to fix the scale bars in the temperature and salinity plots for consistency.

One of the reviewers felt that there was a good review of license conditions and that including what other jurisdictions are doing was a good addition. The reviewer felt that there should be a good summary section about what the potential mitigation steps would be, noting that a lot of what others are doing is discussed earlier in the document. The reviewer felt that clearly laying out mitigation options, and if they may or may not work, could be valuable. The reviewer recognized that the authors cannot endorse any particular mitigation method, but felt there would be value in providing a summary of options in the conclusions section, rather than the recommendations section. The authors' perspective was that the efficacies of any of these mitigation techniques have not been measured, so it would be premature to state "if you do this, you will reduce risk". For this reason the authors have simply suggested more research into the efficacy of different methods.

There was a suggestion that the recommendation stating "to eliminate the risk of introduction, you need to stop moving shellfish" could be shifted to the conclusions section.

The CSAP office suggested saying "in decreasing order of stringency, these are the methods of mitigating risk of introduction". The authors stressed that they didn't evaluate the efficacy of any of the methods, as it was beyond the scope of the paper, and that they could not make recommendations without first conducting research comparing the different methods.

One reviewer stated that the introduction of NIS is a time sensitive issue and that waiting to determine the absolute risks of introduction could be detrimental. It was suggested that the techniques described in Table 11 could be expanded and examples could be provided. The authors were concerned that the examples could be misconstrued as advice. The Committee felt that a summary paragraph on potential mitigation techniques, with some examples, would be appropriate in the summary section of the document.

The Committee asked if we have a good understanding of the density and distribution of Green Crabs on the west coast of Vancouver Island. There is unpublished catch per unit effort (CPUE) data showing that they extend from Sooke northward along the west coast. Temporal dynamics are unknown, but the unpublished trapping data suggest that the populations are highly volatile with large changes in abundance. The Committee noted that some additional text on the surveys that were completed of processors on the east coast of Vancouver Island, showing that no Green Crabs have been detected to date, may help put the overall issue into context. The authors felt this was beyond the scope of the work being undertaken. A member of the Committee mentioned that it would be helpful to have maps of where the processor sample sites were, however the authors are not able to add specific locations to the paper for privacy reasons.

Following the presentation and discussion of the reviewers' comments, the Committee posed additional questions to the authors, beginning with Section 2 of the paper and proceeding through to Section 6.

Section 2

General discussion took place around the applicability of this paper to commercially harvested wild shellfish, given that the paper only focuses on aquaculture. Opinions were that the paper addresses moving shellfish from one place to another, and that it doesn't matter if it's cultured or commercially harvested, meaning the paper is relevant beyond just aquaculture. The authors concurred and will add text in the introduction to clarify that the study addressed a few cultured shellfish species, but that the research is applicable to other forms of transfers and other shellfish species.

A Committee member indicated that there was a bit of context missing in the introduction of the Working Paper concerning the role of CFIA and why this study was done. The Committee would like to see a more complete description of how the consultations between the authors and the CFIA led to the CFIA changing their practices to reduce or eliminate the possible movement of Green Crab from the west to east coast of Vancouver Island. The authors agreed and will add wording to describe the consultation process, including why and how CFIA changed their practices; they also agreed to work with CFIA to ensure that what CFIA does is accurately represented in the paper.

Section 3

The Committee requested clarification on the control mussel group used in the experiment. The authors explained that a control group was included as part of the investigation on mussels in the biotoxin monitoring program. Five samples of the California Mussel, *Mytilus californianus*, were collected from the collection site in Tofino. These samples were processed immediately at the Pacific Biological Station and were not outplanted experimentally. They attempted to

replicate the methods used in the biotoxin monitoring program, and therefore they did not rinse or scrub the mussels. The authors agreed to clarify the use of mussel controls in the paper.

An issue was raised with respect to the handling methods used during the oyster sampling. The concern was that the samples were not handled exactly the same way that Industry handles the product. The authors acknowledged that there were differences and that they tried to the best of their ability to mimic industry practices, but that the required sampling procedures didn't allow for identical handling methods. This issue will be reflected in the SAR's uncertainties section.

The Committee recognized that surveys have not yet found Green Crabs in the Strait of Georgia, despite large amounts of unregulated/regulated product being transferred into the Strait from the west coast of Vancouver Island since the 1990's. The authors agreed to add a comment that trapping has been done in the Strait of Georgia and that Green Crabs haven't been found yet. The Committee also noted that there are additional factors at play, other than just cultured shellfish transport, affecting the establishment of Green Crabs in the Strait of Georgia. The authors agreed to include some text mentioning that other factors are at play in establishing a population. The Committee may add a recommendation to the SAR, to conduct studies on where Green Crab populations have been established.

There was a question regarding whether there is a carrying capacity limit on the number of Green Crabs that could become entrained. The authors stated that they didn't know the relationship between density of Green Crabs and probability of entrainment, nor quantity of entrainment. They recognize that this is an important question, however they are unable to provide any insight into this issue with the data and information currently available.

The Committee noted that in section 3.10.5, the paper says that the number of Green Crabs found could have been underestimated. Discussion ensued about the uncertainties around the number of Green Crabs that may become entrained. Some committee members believed the Research Document focused too much on the potential underestimation in the number of entrained Green Crabs. While the presented estimate could be low, given that the amount of sampling conducted was very small and the amount of entrainment time was also short, it could also be high, as there are large densities of Green Crab in Pipestem Inlet which may have led to a higher number of entrained Green Crab compared to lower-density locations. The authors could not say whether the results are conservative or not as there is insufficient information to indicate if Green Crab numbers are high or low. There was a concern that in the experiment the researchers were intentionally trying to entrain crabs, but this is obviously not the goal of Industry. The authors indicated that they were not intentionally trying to entrain crabs, but that they were trying to see if it was possible, and therefore if the potential exists.

The authors used historical production values of cultured shellfish from the west coast of Vancouver Island and their experimental results to predict how many Green Crabs may have been transported in total, given the amount of shellfish product being moved from the west to the east coast of the island, as this value was explicitly requested by DFO FM in the TOR (consideration #3). The Committee discussed issues around the use of extrapolation, including the associated uncertainties and how it may be interpreted. The point of the extrapolation was to estimate how many crabs may have been transferred historically. It was recognized that the values should be treated with caution. There were some suggestions on how to fine tune the extrapolation (e.g., by splitting the data by harvest type, by subareas, or culture types), but due to privacy issues these methods were not possible. There was also a concern with people being able to scale up how many Green Crabs per volume of shellfish with the low amount used in this study, and there was a suggestion to provide number of Green Crabs per 1000 kg of shellfish. The authors didn't feel that changing the way they reported the numbers would change the caveats. The Committee questioned why numbers from 1991 to 2010 were used

considering Green Crabs weren't observed in BC until 1999. The authors agreed to only use data for the time period for when Green Crabs were known to be present (post 1999).

Section 5

The Committee suggested Section 5 should be re-named "Conclusions". The Committee also suggested some wordsmithing to clarify points 2 through 5 of this section. The authors were open to these suggestions.

The wording in point 2 could be changed to: "potential propagule pressure may be sufficient to overcome transfer barriers...based on historical industry production". The wording in point 4 could be changed to "based on a literature review...". The wording in point 5 could be changed to "based on experimental results, the present conditions of license...".

Section 6

There was some confusion over the use of "to inform" in numbers 3 and 4 of this section, and it was suggested for number 3 to change wording to "to facilitate further development". Further wording suggestions included replacing "movement of shellfish" with "transfers of shellfish from infested to non-infested waters". The Committee stated that they recognize the difference between recommendations associated with "eliminating risk" versus "reducing risk". The Committee also pointed out the need to recognize that this isn't the only vector, and that the goal is not to stop all of the shellfish transfers. The authors agreed to go back to the synopsis, conclusions, and recommendations and to craft a final end piece.

CONCLUSIONS

Based on the paper, the presentation, the reviews, and the proceeding discussions, the Committee concluded that the presented paper provides an appropriate evaluation of transfers of harvested shellfish products, from the west to the east coast of Vancouver Island, as a potential vector for European Green Crab and other non-indigenous invertebrate species. The paper is accepted conditional upon the following revisions:

- Add a paragraph to the introduction on invasive tunicate species, and possibly bryozoans if there is sufficient information, to help provide context to the study.
- Add information on the timing and location of Green Crab larvae and that current patterns prevent natural movement of larvae from the west coast to the east coast of Vancouver Island.
- More clarity on methods used in the oyster experiment is required including: stating that the oysters were suspended, how long they were suspended for, and how large each sample was.
- Clarify that it was unknown whether Green Crabs were present at the processor collection sites or not.
- Add wording to clarify why the temperature and salinity data were collected.
- Add text in the introduction to clarify that a few cultured shellfish species were examined in this study, but that the work is applicable to other forms of transfers and other shellfish species, providing an example or two.
- Work with CFIA to ensure that CFIA's role and procedures are accurately represented.
- Clarify the use of mussel controls in the study.
- Add a comment that trapping has been done in the Strait of Georgia and that Green Crabs have not been found there yet.

- For the historical extrapolation, only use data for the time period when Green Crabs were present (post 1999).
- Authors agreed to make changes to the Conclusions and Recommendations as per the following comments:

Committee Recommendation: Rename section 5 to "Conclusions"

Conclusions

1) The movement of shellfish (clams, oysters, and mussels) from NIS-infested areas is a vector for both mobile (*e.g.* green crab) and sessile (*e.g.* tunicates/ bryozoans) NIS. This is true regardless of the intended end-use of the shellfish (*e.g.* commercial culture, biotoxin monitoring programs).

   a. Green Crabs were entrained with all three shellfish species examined.

   b. Three NIS tunicates and two NIS bryozoans were also entrained in most of the cultured shellfish species examined.

   c. Additional species were also entrained and included native: fish, non-cultured shellfish, crabs, shrimp, macrophytes (seaweeds, seagrasses and algae), and snails among many others.

Committee recommendation: Keep Conclusion 1 as is.

2) The potential propagule pressure due to the shellfish movement vector may be quite high based on extrapolations of historical industry production.

Committee recommendation: Change to "The potential propagule pressure due to the shellfish movement vector may be sufficient to overcome transfer barriers, based on historical industry production".

3) The only mechanism to ensure NIS are not inadvertently moved from infested to non-infested waters via this vector is to restrict all movement of shellfish (i.e. strict quarantine).

Committee recommendation: Keep Conclusion 3 as is.

4) No mitigation measures to remove or destroy NIS on cultured shellfish are 100% effective, suggesting any movement of shellfish poses some level of invasion risk.

Committee recommendation: Change to "Based on a literature review, no mitigation measures to remove or destroy NIS on cultured shellfish are 100% effective, suggesting any transfer of shellfish poses some level of invasion risk".

5) Present conditions of licence do not eliminate NIS propagule pressure. Due to gaps identified it is probable that the intended reduction in propagule pressure is not realized.

Committee recommendation: Change to "Based on results of the experimental and processor studies, the present conditions of licence do not eliminate NIS propagule pressure. Due to the gaps identified it is probable that the intended reduction in propagule pressure is not realized."

6) A conceptual framework was developed to identify control points where management intervention, such as application of license conditions, could lower propagule pressure and hence invasion risk. A full assessment of the relative effectiveness of each control point in the framework is beyond the scope of this project.

Committee recommendation: Keep Conclusion 6 as is.

RECOMMENDATIONS

1) To eliminate the introduction potential of NIS from infested to non-infested waters on transferred shellfish, movements of shellfish need to be halted.

Committee recommendation: Change to "If the management objective is to fully eliminate the risk of introducing potential NIS, from infested to non-infested waters, on transferred shellfish, the transfer of shellfish should be halted".

2) To reduce the introduction potential of NIS from infested to non-infested waters on transferred shellfish, various mitigation measures need to be invoked.

Committee recommendation: Adopt Recommendation 2 as it stands.

3) To inform the conceptual framework for risk mitigation, a risk assessment needs to be undertaken to understand the relative reduction in propagule pressure at each step, under various scenarios, of the framework.

Committee recommendation: Change to "To facilitate further development of the conceptual framework for risk mitigation, a risk assessment needs to be undertaken to understand the relative reduction in propagule pressure at each step, under various scenarios, of the framework."

4) To inform the relative reduction in propagule pressure at each step of the conceptual framework, further research is required.

Committee recommendation: Adopt Recommendation 4 as it stands.

SOURCES OF UNCERTAINTIES

The Committee listed the following sources of uncertainties which would be prudent to include in the SAR.

- Extrapolation process has uncertainty.
- Acknowledge the limitations of the processor study, given that it only covered six months and the density of the Green Crab population within the collection site was unknown.
- The length of time the cultured product was out does not reflect aquaculture practices.
- Other species and other types of shellfish culture were not considered experimentally.
- Small sample size and small experiments were used to test industry-wide possibility of transfer; there are uncertainties associated with extrapolating to larger- scale rinsing methods.
- Experimental sites may not be representative of various areas of the west coast of Vancouver Island.

ACKNOWLEDGEMENTS

Matthias Herborg (Government of British Columbia, Ministry of Environment, Conservation Science Section, Aquatic Invasive Species Coordinator) and Cynthia McKenzie (DFO – Science) each provided a thorough written review of the working paper. Their efforts in providing this feedback to the committee and authors are greatly appreciated. Also, the committee greatly appreciated Jessica Finney acting as rapporteur for the meeting.

APPENDIX A: AGENDA

Regional Advisory Process (RAP)

Evaluating transfers of harvested shellfish products, from the west to the east coast of Vancouver Island, as a potential vector for European Green Crab (*Carcinus maenas*) and other non-indigenous species

December 3-4, 2013

Pacific Biological Station
Nanaimo, British Columbia

Chairperson: Nicholas Duprey

Day 1 - Tuesday, December 3rd 2013

Time	Subject	Presenter
0900	Welcome & Introductions. Review Agenda, CSAS Overview/Procedures, Review of Terms of Reference	Nicholas Duprey
0930	Presentation of Working Paper	Lyanne Curtis
1030	Points of clarification	
1045	***Break***	
1100	Reviewer Presentation & Author Response	Matthias Herborg
1145	Reviewer Presentation & Author Response	Cynthia McKenzie
1230	***Lunch Break***	
1330	General questions	RAP Participants
1515	***Break***	
1530	Discussion and review of working paper	RAP Participants
1630	***Adjournment***	

Day 2 - Wednesday, December 4th 2013

Time	Subject	Presenter
0900	Welcome & Introductions – Recap of Day 1	Nicholas Duprey
0930	Discussion and review of working paper	RAP Participants
1030	***Break***	
1050	Discussion and review of working paper	RAP Participants
1215	***Lunch Break***	
1300	Forming Conclusions and Advice for Science Advisory Report	RAP Participants
1420	***Break***	
1440	Finalizing Science Advisory Report	RAP Participants
1630	***Adjournment***	

APPENDIX B: ATTENDEES

Last Name	First Name	Affiliation
DFO		
Burgoyne	Lyanne	Science, MEAD[1]
Chamberlain	Jon	Fisheries Management
Clark	Dan	Science, MEAD
Curtis	Dan	Science, MEAD
Duprey	Nick	Science, MEAD
Finney	Jessica	Science, MEAD
Fogtmann	David	Fisheries Management
Gillespie	Graham	Science, MEAD
Gordon	Elysha	Fisheries Management
Kronlund	Rob	Canadian Science Advice Pacific
Leus	Dan	Science, MEAD
MacDougall	Lesley	Canadian Science Advice Pacific
McKenzie	Cynthia	Science, Aquaculture Research
Norgard	Tammy	Science, MEAD
Parker	Guy	Fisheries Management, SCA[2]
Pearce	Chris	Science, MEAD
Rogers	Juanita	Fisheries Management, SCA
Therriault	Thomas	Science, MEAD
Thompson	Matt	Science, MEAD
EXTERNAL		
Herborg	Matthias	Government of BC
Matkin	Haley	Co-author
McLellan	Gordy	Mac's Oysters Ltd.
Morello	Gerry	Canadian Food Inspection Agency
Munro	Alex	Fanny Bay Oysters
Seeley	Barry	C.A.R.S. Ltd.
Yakimishyn	Jennifer	Pacific Rim National Park Reserve
Zharihov	Yuri	Pacific Rim National Park Reserve

[1]MEAD = Marine Ecosystems and Aquaculture Division.
[2]SCA = South Coast Area

APPENDIX C: TERMS OF REFERENCE

Evaluating transfers of harvested shellfish products, from the west to the east coast of Vancouver Island, as a potential vector for European Green Crab (*Carcinus maenas*) and other non-indigenous invertebrate species

Regional Peer Review - Pacific Region

December 3 & 4, 2013
Nanaimo, British Columbia

Chairperson: Nicholas Duprey

Context

Wild and cultured shellfish harvested on the west coast of Vancouver Island (VI) are currently sent to processing plants on the east coast of VI or to the lower mainland as no commercial shellfish processing facilities exist on the west coast of VI. Historically, processors were allowed to 'wet store' large quantities of harvested product in the intertidal zone next to their plants or on aquaculture tenures, processing product as time and markets allowed. It was identified that this practice of wet storage could present the potential for the introduction of non-target aquatic invasive species – in particular, high risk species such as the European Green Crab (*Carcinus maenas*) that can negatively impact shellfish aquaculture (Therriault et al. 2008) – to areas where they currently are not present in the Strait of Georgia.

In order to address concerns regarding the possible introduction and/or movement of Green Crabs as a result of wet storage practices, and without research into this question, DFO adopted a precautionary approach to the management of the commercial intertidal bivalve wild fishery and aquaculture operations in 2010 that restricts wet storage and requires visual inspection and rinsing of all shellfish products harvested on the west coast of VI.

In 2011–2013, under the Program for Aquaculture Regulatory Research (PARR), research to investigate transfer potential of Green Crabs on shellfish product was conducted. With this PARR program now complete, Fisheries Management, Aquaculture Division has requested Science Branch to provide advice respecting the potential for transfers of harvested shellfish products to be a vector for the movement of European Green Crabs and other non-indigenous invertebrate species from the west to the east coast of VI and, should such a potential exist, advice on measures to mitigate the risk. This advice will also be provided to the Canadian Food Inspection Agency (CFIA) for consideration respecting the design of their biotoxin monitoring program.

Objectives

This Regional Peer Review (RPR) meeting will review and provide advice based on the following working paper:

"Evaluating transfers of harvested shellfish products, from the west to the east coast of Vancouver Island, as a potential vector for European Green Crab (*Carcinus maenas*) and other non-indigenous invertebrate species" by L.J.F. Curtis, H. Matkin, D.L. Curtis, M. Thompson, F. Choi, P. Callow, G.E. Gillespie, T.W. Therriault, and C.M. Pearce. CSAP Working Paper 2013/P33.

The objective of this RPR is to assess the potential for transfers of commercially harvested shellfish products to be a vector for the movement of European Green Crab and other non-indigenous invertebrate species from the west to the east coast of VI and, should such a potential exist, advice on measures to mitigate the risk.

Specific outcomes and considerations include:

1. Identification and review of the potential processes by which the transfer of a range of cultured shellfish products provide a mechanism by which non-target aquatic invertebrate invasive species may be relocated to new ecosystems using present aquaculture processes.
2. Description of the attributes of European Green Crabs that could influence their ability to establish populations in a receiving ecosystem.
3. Description of the range of transfer potential of European Green Crabs as measured through experimental research and as extrapolated to current and historical commercial shellfish transfers. Provision of considerations around areas of uncertainty and assumptions introduced during the experimental research and extrapolation process.
4. Evaluation of whether the information, data, and analysis presented for European Green Crabs can be used to provide advice on the potential for current bi-valve harvest practices to be a vector for other non-commercially harvested aquatic invertebrate invasive species.
5. Advice on potential mitigation measures, including their efficacy, which may be utilized to reduce the potential for transfer of non-target aquatic invertebrate invasive species.

Expected Publications

- CSAS Research Document (1)
- CSAS Science Advisory Report (1)
- CSAS Proceedings (1)

Participation

- DFO Science
- DFO Fisheries Management
- Province of BC
- Commercial fishing interests
- Parks Canada
- Canadian Food Inspection Agency

References Cited

Therriault, T.W., Herborg, L.M., Locke, A., McKindsey, C.W. 2008. Risk assessment for European green crab (*Carcinus maenas*) in Canadian waters. DFO Can. Sci. Advis. Sec. Res. Doc. 2008/042.

APPENDIX D: WRITTEN REVIEWS

REVIEWER 1

Fisheries and Oceans Canada

Canadian Science Advisory Secretariat (CSAS)

Regional Peer Review Process - Pacific

Written Review

Date: 25th of November 2013

Reviewer: Matthias Herborg PhD, BC Ministry of Environment

Working Paper Title: Evaluating transfers of harvested shellfish products, from the west to the east coast of Vancouver Island, as a potential vector for European Green Crab (Carcinus maenas) and other non-indigenous invertebrate species

Overall comments:

This is an interesting study, looking at the actual numbers of non-indigenous species (NIS) transported by shellfish movements. Its well designed and presented, and I found it to be a good read. The research is a very informative and applied aimed at informing managers about the risk of a specific vector of potential invasive species movements.

The **experimental field study** is well designed and the results very informative to better understand the species associated with the movements of the three different types of products. There are some details which need to be clarified, see the detailed comment section, but otherwise it is well designed and written. The **processor study** is a good complement to the experimental field study, looking at actual commercial shellfish product and its NIS load.

Reading these sections two larger issues should be rectified. The focus f the study is green crab, however also other NIS, mainly tunicates and bryozoans. I have the feeling that given their prevalence, the latter two groups deserve also a short literature review with respect to their life history, impacts and distribution as Green Crab had. This will help readers without knowledge of these groups to better understand the potential risk these species might pose.

The other component I think would also help to understand the findings around Green Crab juvenile stages would be a quick summary of the timing of larval release and development over the seasons on the West Coast as far as known, maybe puling information from their native range in.

The **potential mitigation measures** section is very informative with respect to what the current regulations are and how effective they are. It is clear based on the study findings that, while the current aquaculture license conditions try to reduce the risk of NIS movement into the Strait they clearly fall short.

The one shortcoming I see of this section is that the conclusions and recommendations are too general, we all know that this will be the most read section of this document so it should really lay out clearly what measures could be taken now, and which would require regulatory changes and infrastructure investments, but should be implemented as soon as possible.

While there are clear activities laid out in the in-depth section these are not captured in the conclusion and recommendation section. Asking for all shellfish transport to be halted under

point 1 is actually something that could happen, if a processing plant could be established on the West Coast, but the authors do not mention that.

A whole number of other mitigation measures, around the effluent of processing plants and the disposal of shells and other materials have to be specifically mentioned in the recommendations section to make this useful. For example, why can't you suggest aligning BC regulations with Washington State regulation as far as the disposal of shells post processing? This sounds to me like it would not be an unreasonable hardship to the industry.

Running the effluent of processing plants through some pretty simple gravel filtration or something similar would also greatly reduce the likelihood of NIS reaching the ocean, and again would probably be fairly cheap and simple to implement.

Finally, it is not clear what exactly is going on with the CFIA and their PSP program, has their movement of mussels stopped now, and if not how could that be mitigated to stop the spread, e.g. get mussels from the east coast of VI?

I understand that more research and risk assessments would help with more detailed management choices, however given the results from your study, I think all the crucial information is there, and rather than spending another couple of years on research and risk assessments maybe the focus should shift to a couple of on the ground mitigation actions and more effective shellfish aquaculture license conditions.

Detailed comments:

Pg 4 first para: What about the Green Crab findings along the central coast?

Pg 6-8: 'Entrainment of NIS on cultured shellfish' section: It is worth to highlight that *Mytilus edulis* and *M. galloprovinciales* are natural habitat and food sources for Green Crab in their native range, which increases the likelihood of them selecting this habitat. I also don't see tunicates mentioned here. While the species are present on both sides of Vancouver Island it should be mentioned that shellfish transfers can move them to new areas, highlighting the results for the risk assessments.

Pg 13 Check spelling in the citations, its Herborg, not Herbourg

Pg 18 'Oysters' section, how long where the oyster trays left on the beach prior to sampling?

Pg 19 'Shellfish Sample Collection' I assume one samples is one bag of mussels and cams, but this has to be spelled out clearly, For oysters I am not sure what substitute one sample, please clarify.

Fig 7+8: I am wondering if it would be more informative to just have two summary graphs here combining all the individual data, showing the size class distribution of males and females for each of the sites overall. The information on the effectiveness of the different sampling methods I in fig 6 so the extra information here is only what the size differences for the different traps are which I find less important than giving me a good size distribution or the population overall.

Fig 9 try and make the figure larger, its very hard to see the variation in the Sechart time series

Pg 38 2nd paragraph first sentence. Sorry I am not following what is being described here with regards to the Green Crab found post out planting and what its significance is? Please rewrite.

Pg 38 3rd paragraph. Part of the preference of Green Crab to shellfish beds is that that is part of their natural native habitat

REVIEWER 2

Fisheries and Oceans Canada

Canadian Science Advisory Secretariat (CSAS)

Regional Peer Review Process - Pacific

Written Review

Date: November 23, 2013

Reviewer: Cynthia McKenzie, DFO Newfoundland and Labrador Region

Working Paper Title: Evaluating transfers of harvested shellfish products, from the west to the east coast of Vancouver Island, as a potential vector for European Green Crab (*Carcinus maenas*) and other non-indigenous invertebrate species

The information provided in this working paper was very interesting and quite timely. The introduction of larval, juvenile and adult Green Crab from areas where shellfish aquaculture operations are being conducted to other regions through transfer of product including processing is a growing problem in many regions of Canada. Information provided in the document is not only useful in BC but also can be applied in some situations in other regions. The appendix in particular with the documentation of the various national, international and regional policies will be very useful to a broad audience as well as local managers making decisions on transfers in BC. The conceptual model for the control points based on HACCP is an important model and in my opinion it (or something like it) should be the basis of all I&T for NIS in all regions. (p46).

The purpose of the working paper was clearly stated. The data and methods did support the conclusions for the most part for the field study however there were a few areas where the conclusions were a little broad and some of the methods had some challenges for the processor study.

The field study did highlight and quantify the risk for shellfish aquaculture, particularly those cultured in benthic environments, less so with suspended culture. In particular I was impressed with the size ranges of larval and juvenile Green Crab found in the study, this highlights the problems with simple visual surveys and rinsing. It also highlights the larval stages which I think the risk is currently little understood or not taken into consideration by managers. Finding Green Crab in and among the clumps of shellfish is an important point for regulations for transfer. The simple rinsing (as pointed out freshwater, saltwater?) is demonstrated to be ineffective. This is not surprising but an important point that is clearly demonstrated with the field study. Also of vital interest in management and Introduction and transfer conditions was the month long period where the larvae and juveniles were found. Working around the reproductive season suddenly becomes much more difficult.

Although not the primary focus of the working paper but of important interest was the information on other NIS being transferred. Introduction and Transfer recommendations and the decision to move aquaculture product must consider not just Green Crab but other NIS. Mitigation methods which are most effective must be targeted. As suggested research on mitigation for NIS without harming the shellfish is needed. In Newfoundland we are currently conducting studies on removing /destroying juvenile Green Crab associated with mussel transfers. Vickerson et al 2010 conducted research on mitigation of colonial tunicates that would not impact mussel seed being transferred from NIS positive sites.

A major weakness of at least one key part of the processor study did lead me to question why it was conducted at all. The processor study utilized an aquaculture site where the presence or absence (much less the density) of Green Crab was unknown. If the point is to determine if Green Crab are being transferred through current processing, I think it critical to know if the site is expected to have green crab. I think this is well beyond uncertainty. As no Green Crab were found in the processed green crab. I am not sure what information that provides. Yes other NIS were found and that is important also but is there any idea of the concentration (heavily fouled, rare?) at the site, this would speak to risk. I also thought the extrapolation of transport was a weakness in the document. Quantifying movement is difficult but I was not convinced these numbers were completely valid. This does not lessen the overall demonstration that the risk is high and increases with increased movement.

Regarding the advice to decision-makers I think the field study clearly shows that the risk of introducing NIS through transfer of shellfish (particularly benthic locations) is very high and should not be permitted without specific precautions. Clearly "rinsing" in the currently license is not adequate and investigations should be made regarding heated seawater dips, freshwater rinse (with or without pressure in controlled conditions) and other treatments should be studied.

Additional research should include a study from an aquaculture site where Green Crab abundance is known so that the actual risk could be determined. I am not sure if BC has mussel or shellfish seed sites and if they are present they should be evaluated as they are a high risk for transfer to other locations.

The following comments are more directed toward the clarity of the working document and some suggestions for improvement for readability.

I found the map figures to be very busy and difficult to read. I am not sure you need the level of detail in the maps and the font for the place names was small and sometimes illegible. Perhaps because I am not as familiar with the study area I found the inset in Fig 2 very difficult to decipher and took some time figuring out where the box was located, again due to the overall business of the map. Figure 3 in particular was difficult to read and would strongly recommend the replacement of the white circles with something that stands out better.

Figures 4 and 5 were also difficult to read and understand. The use of light gray was a problem for me as the contrast was not clear enough to clearly compare the trends. I suggest a more contrasting color or style. Also these are very busy and is difficult to determine the point of the figures. The trends may be more apparent if the data was averaged and you have less clustering. I was not really clear on the point of the salinity and temperature data and the role in played in the study as no direct correlation was made – was this just background information on the study sites? More should be said in the text on why the authors feel this information is relevant. What do these variations and ranges mean for NIS transport. Are these values typically for aquaculture locations?

Very good point on wet and dry transfer (p8 2.2.10), also important in mantle water transport vector this could be an important control point.

Table 4 not sure why clams are not included, if this was explained it was not clear.

Figure 9 gray also very hard to see, recommend using alternate color or style.

P. 35 36 Again I think you are stretching your data here, particularly as it is incomplete over the years covered. May need to be more general regarding exportation.

P.40 second paragraph salinity ranges for adult and juvenile Green Crab seem low, in NL they range is at least into 32 ppt.

Recommendations are clear and supported by the study. I am not sure how practical complete halt to shellfish movement would be, perhaps prior to full research results, Science working with I&T to provide precautionary approach would be possible on case by case basis.